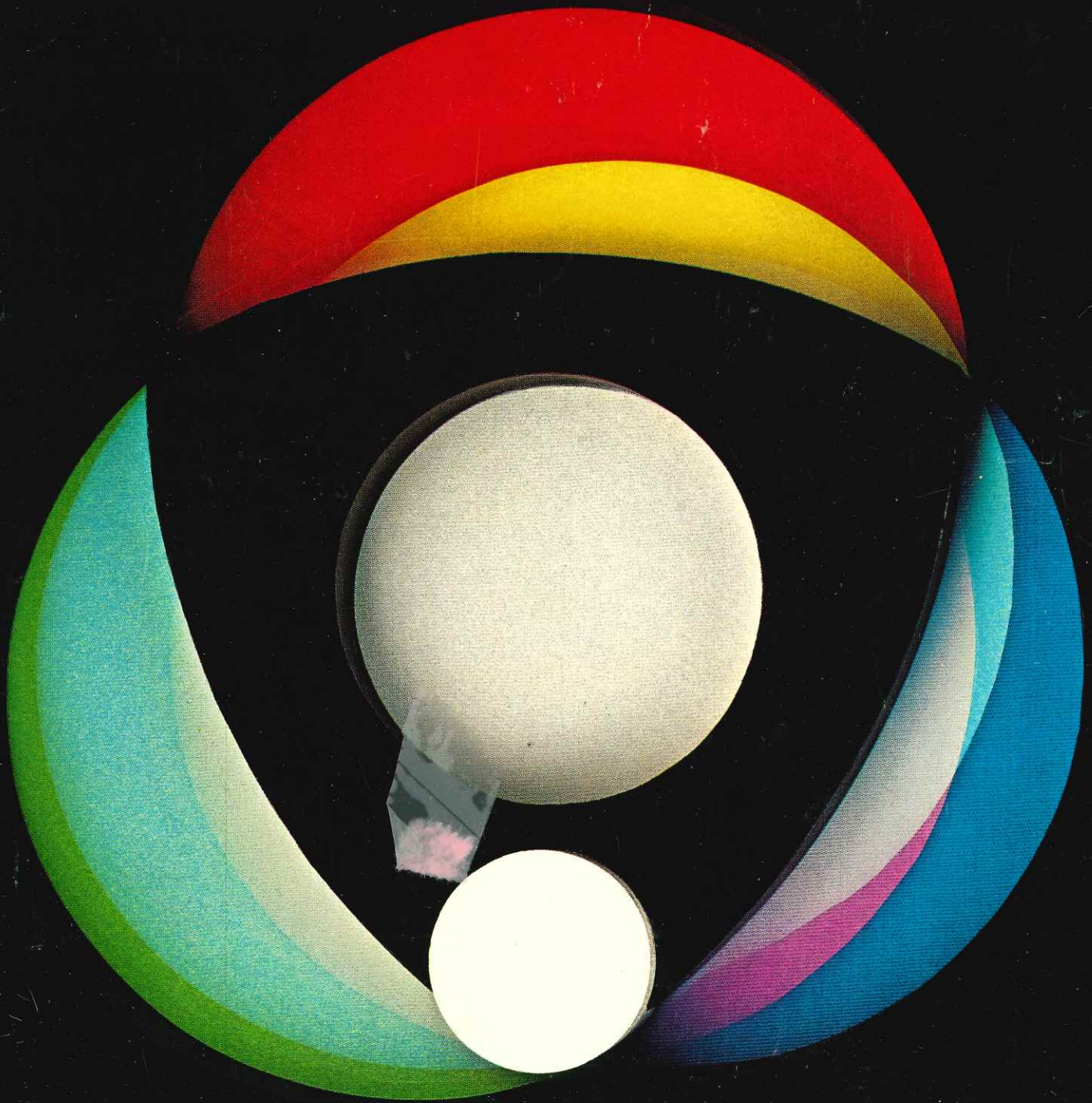
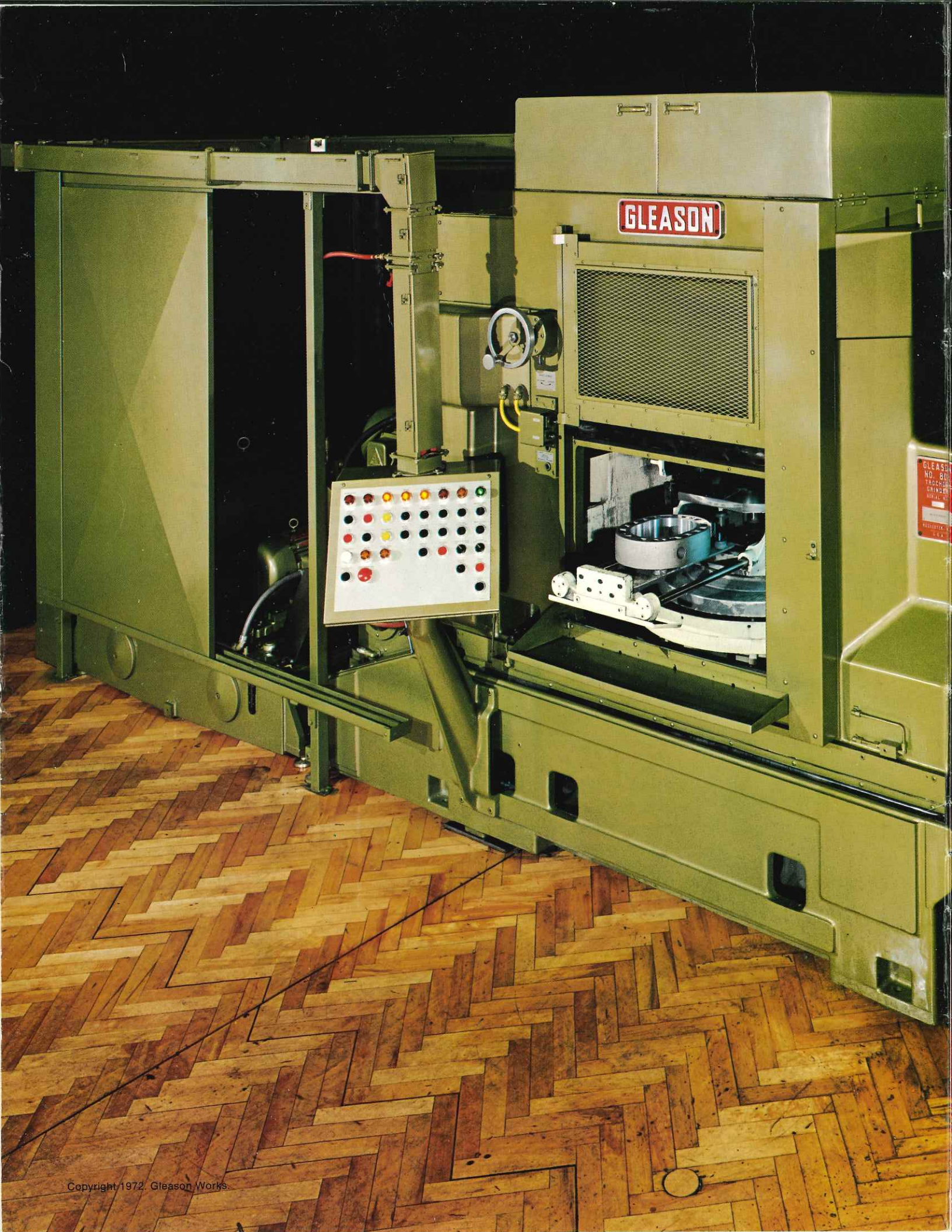


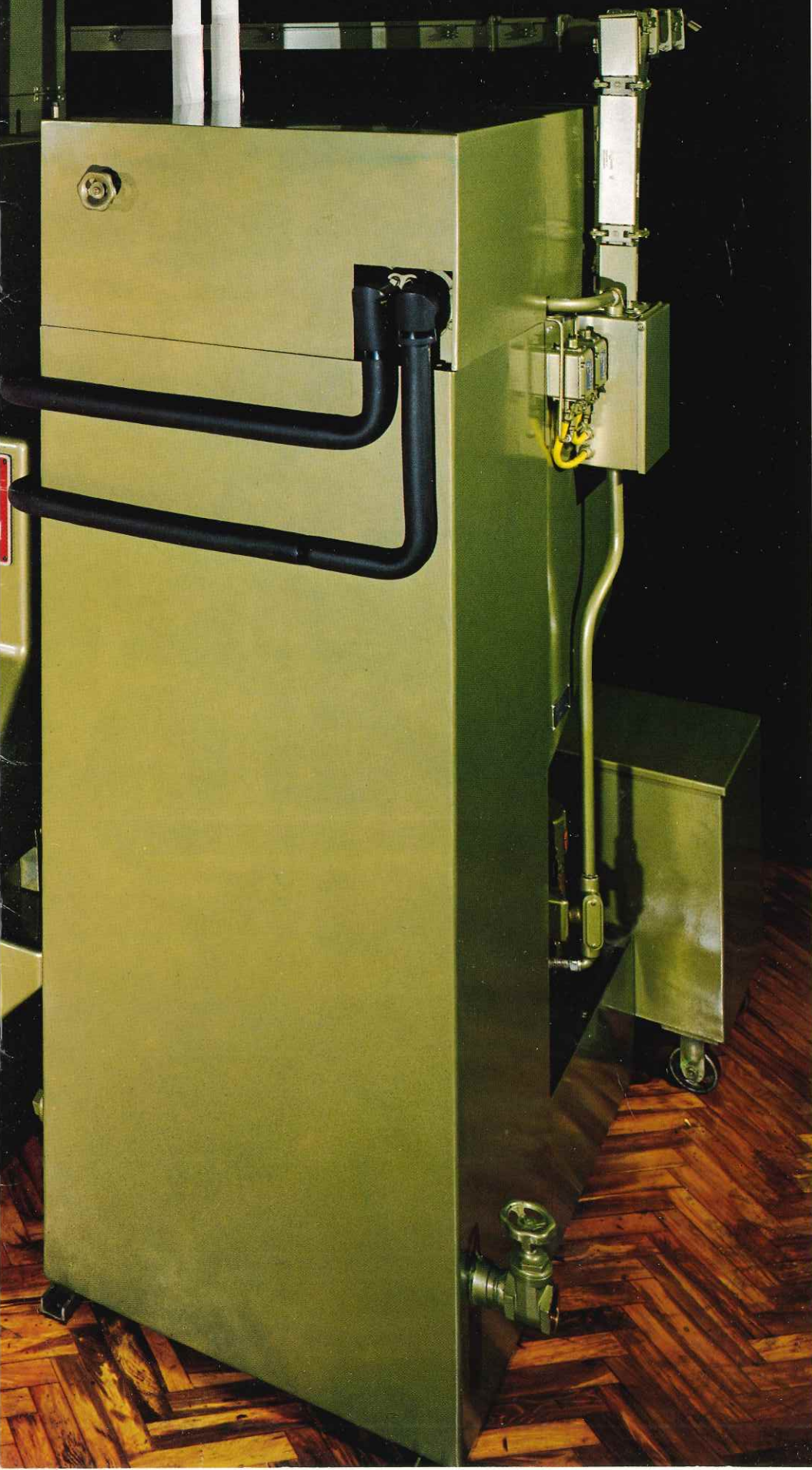
# Gleason

## No. 808 Trochoid Generating Grinder





**A new approach to  
high volume, precision grinding of rotary  
combustion engine housings.**



The Gleason No. 808 Trochoid Generating Grinder is a completely new concept for producing highly accurate trochoidal surfaces on a production basis. Its design is based on a unique generating system developed from a detailed evaluation of the requirements for producing the inner trochoidal surface in rotary combustion engines.

Through its unique kinematics, the No. 808 Grinder generates the exact trochoid shape, using simple rotary motions. Changes in size are achieved with four simple machine settings. This inherent design principle permits easy setups, high continuous production, minimum changeover requirements, and long, trouble-free life. Features that make this performance possible include:

**AUTOMATIC OPERATION**

Operating sequence is fully automatic and unit can be arranged for manual or automatic load and unload. Standard machine features include automatic work positioning and clamping, automatic feed, pre-set grinding cycle and rapid wheel dressing.

**GENERATING MOTION**

Used to produce the trochoid shape, the generating principle requires only simple rotary motions that are controlled by pre-loaded, precision, anti-friction bearings. Trochoid shape is the same from machine to machine since it depends only on machine settings and fixed gear ratios in the drive system.

**DIRECT MACHINE SETTINGS**

Adjustments in trochoid size are related to four basic trochoidal parameters and are made by merely changing the machine settings.

**HIGH PRODUCTION GRINDING**

Rugged, generating drive train assures fast metal removal and long-lasting accuracy. High volume coolant flow provides optimum surface finish with minimum part distortion.

**VARIABLE WORKPIECE ROTATION RATE**

Optimizes rate of work surface speed past grinding wheel at all positions around the trochoidal surface.

**ADJUSTABLE WHEEL SPEED**

Provides a means of obtaining optimum grinding conditions. Rotational speed can be automatically increased to compensate for wheel wear. A two-speed option is available.

**TROCHOID MODIFICATIONS**

Changes in theoretical trochoidal shape can be obtained by cam control.

**TRANSFER LINE OPERATION**

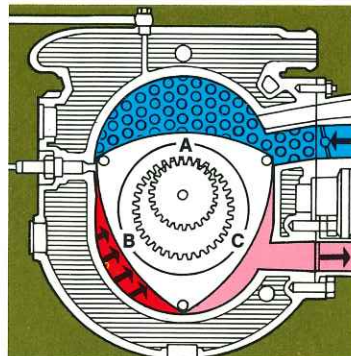
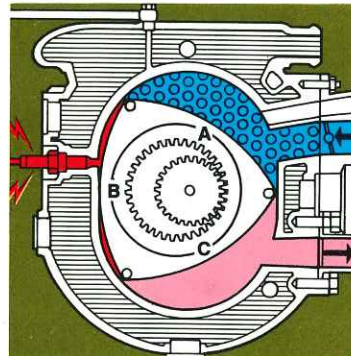
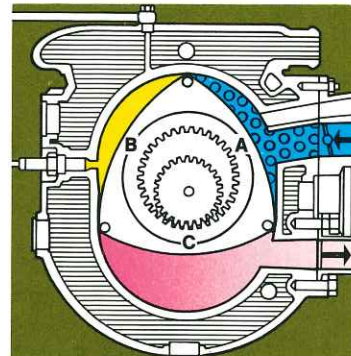
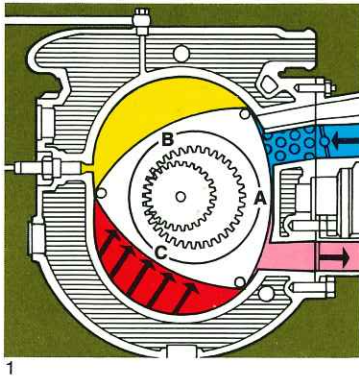
Can be adapted to transfer line operation to suit customer requirements.

The Gleason No. 808 Trochoid Generating Grinder can handle rotary engine housings up to 16" major diameter at high production rates. Productivity can be further increased by automated loading and unloading.

## Gleason machine kinematics for generating the trochoid shape.

### ROTARY ENGINE OPERATION

In the rotary combustion engine, the housing remains stationary while the triangular shaped rotor orbits and rotates about the centerline of the crankshaft. As the rotor orbits, it initiates and completes the functions of intake, compression, expansion (power) and exhaust. The apices of the rotor sweep out a two-lobed epitrochoidal curve during this cycle.

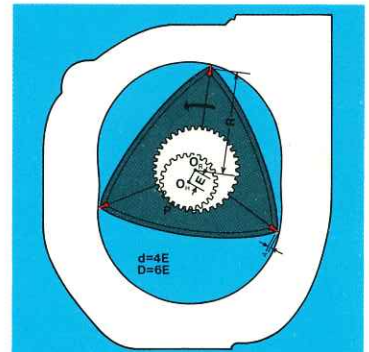


### TROCHOID PARAMETERS

In any given engine, three dimensions completely define the inner shape of the housing. Dimension  $E$  which is the distance between the center of the fixed gear and the center of the rotor's annular gear. Dimension  $R$  which is the distance from the geometric center of the rotor to its theoretical apex point. And Dimension  $A$  which is the seal advance at the tip of the rotor.

### CURVE GENERATING SYSTEM

The basic mechanical elements in a rotary combustion engine which define the trochoid shape of its housing include an internal gear which is integral with the triangular rotor, a smaller, stationary gear which mates with the internal gear; and the apices of the rotor. Each apex of the rotor carries a seal with a rounded face that extends beyond the theoretical apex point. The inner surface of the housing is parallel to the curve swept out by the apex points.



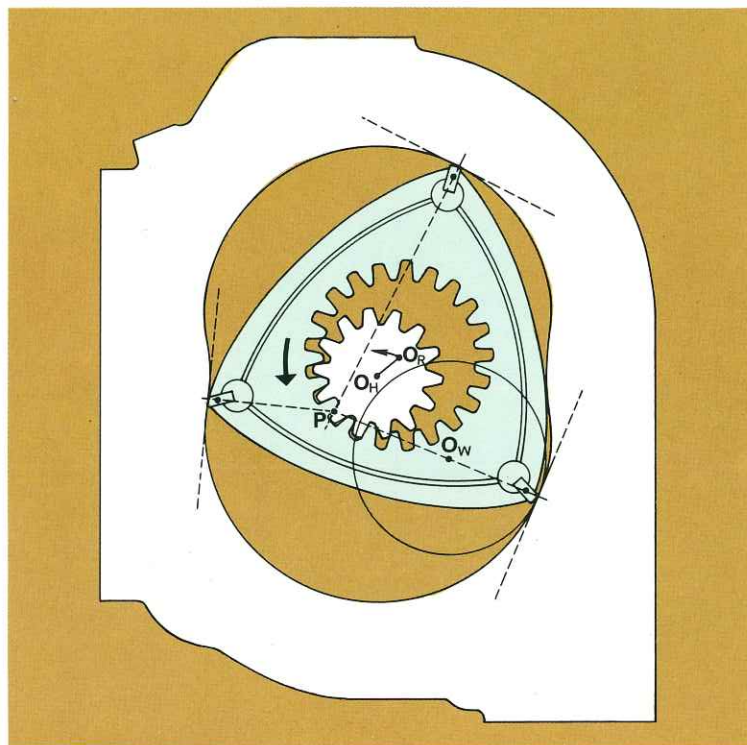
Trochoid parameters  $E$ ,  $R$  and  $A$  define the shape of the inner housing surface.



Rotor tip seals extend outward beyond the apex points. Provision for this clearance must be made in machine settings.

### MAINTAINING WHEEL TANGENT TO WORK SURFACE.

A line drawn from the instantaneous pitch point of the two gears to an apex of the rotor will be normal to the trochoid surface adjacent to the apex. The wheel carrying element of a generating machine must remain centered on such a normal as the wheel is guided around the inner periphery of the housing. In this way, the grinding wheel face remains tangent to the trochoid surface at all times. The wheel carrying element must also be adjustable along this normal for dressing purposes so that tangency and trochoid size are maintained.



A line drawn from the instantaneous pitch point to a rotor apex is normal to the trochoid.

### KINEMATICS APPLIED TO GLEASON MACHINE DESIGN

Gleason Works has developed a curve-generating approach which uses a combination of simple rotary motions to precisely generate the trochoid shape of the engine housing. This approach is based on the concept of an imaginary generating rotor about which the housing moves. (In effect, this is the opposite of what happens in a rotary combustion engine.)

The centerline of the imaginary generating rotor is fixed in position. The housing rotates counter-clockwise about the central axis of the trochoid while the axis simultaneously orbits in a circular path about the fixed axis. The housing rotates at one-half of the velocity at which it orbits. The combination of these motions and velocities achieves correct generation of the desired epitrochoid curve.

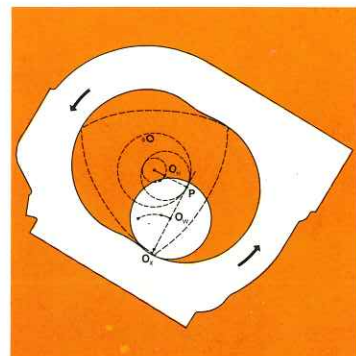
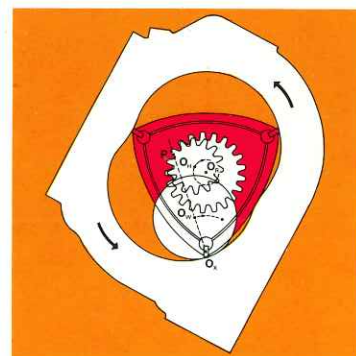
In effect, one apex of the imaginary generating rotor is chosen as the point at which the grinding wheel is to contact the trochoidal surface. A line normal to the curved surface being ground passes through the apex point and pivots on it. The grinding wheel axis remains on the normal line. Therefore, the wheel oscillates about the apex point to maintain the grinding wheel surface tangent to the curve. The wheel axis adjusts radially toward the apex point to compensate for diameter changes caused by wheel dressing.

### TROCHOID PARAMETERS CONVERTED TO MACHINE SETTINGS

The Gleason kinematic system of generation results in a machine that can accommodate any set of trochoidal parameters simply by adjusting four machine settings. Three are directly related to parameters E, R, A mentioned above. A fourth setting is also required to establish the length of the rotating crank for oscillating the arm that supports the tool spindle. This dimension is related to the three other machine settings plus a built-in machine constant.

### MODIFICATIONS IN TROCHOID SHAPE

Where a minor modification in selected portions of the circumference is desired, a shape controlling cam can be provided to move the machine column which carries the wheel. The cam is mounted externally on the machine and turns in conjunction with the work table rotation.

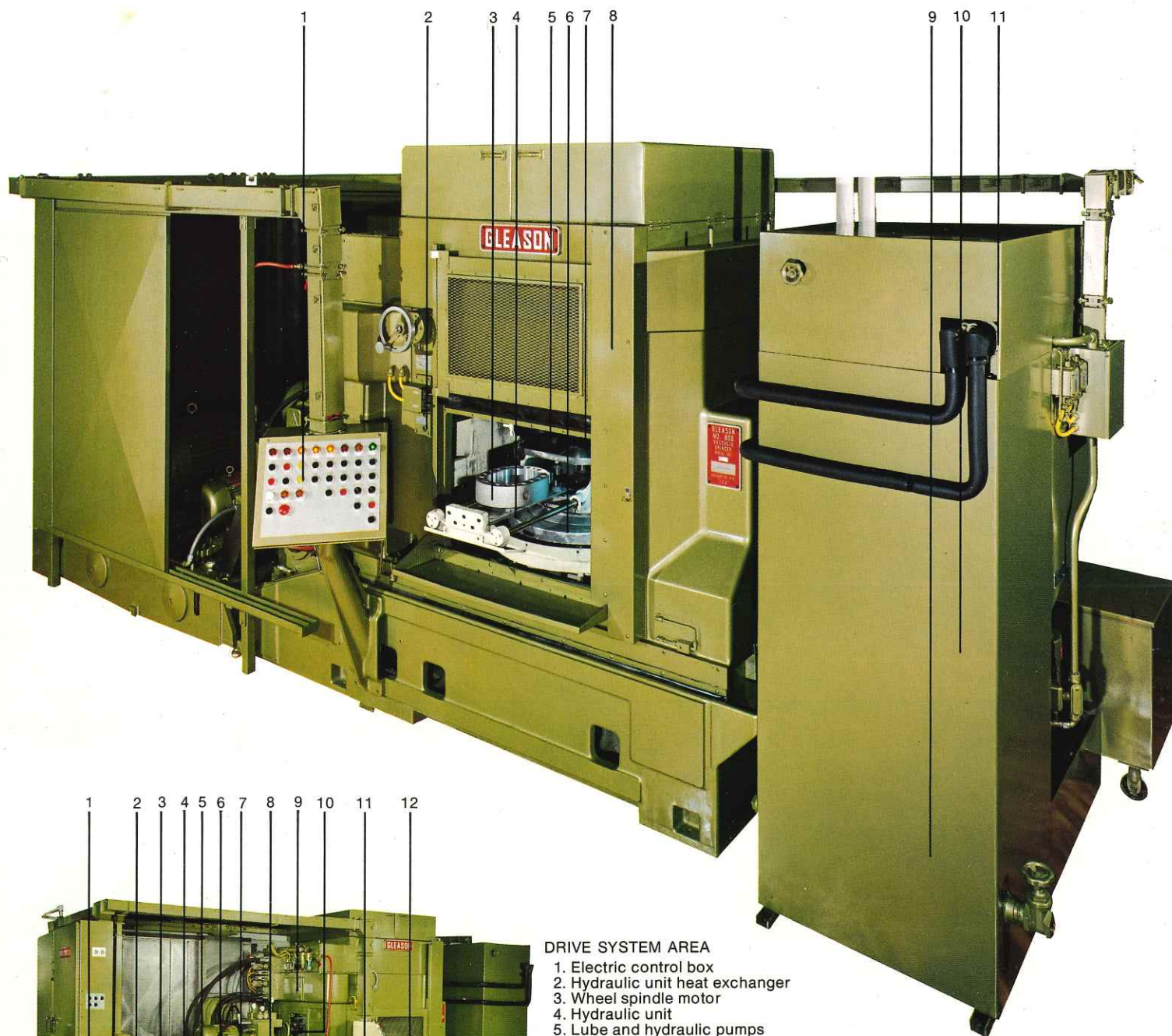


In Gleason Generating Grinder, housing rotates and theoretical rotor is stationary. Grinding wheel oscillates about apex point as it traces out trochoid curve.

# Gleason No. 808 Trochoid Grinder—Machine Features

## WORK AREA

1. Operator control panel
2. "A" setting
3. Rotor housing (workpiece)
4. Work loading tray
5. Wheel dresser
6. Work table
7. Grinding wheel
8. Column
9. Coolant sump
10. Positive type coolant filtration system
11. Coolant heat exchanger



## DRIVE SYSTEM AREA

1. Electric control box
2. Hydraulic unit heat exchanger
3. Wheel spindle motor
4. Hydraulic unit
5. Lube and hydraulic pumps
6. Main drive motor
7. Lube and hydraulic pump drive
8. Trochoid modification cam
9. "L" setting
10. Sequence drum
11. "R" setting
12. "E" setting

SEQUENCE OF OPERATION

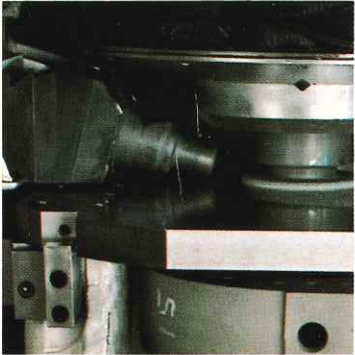
- 1. Machine is set up quickly and easily, using four basic settings.
- 2. Rotor housing is loaded onto work table and automatically clamped into place.
- 3. Pre-set grinding cycle starts. Grinding wheel begins to rotate at predetermined speed. Wheel dressing occurs, if necessary. Wheel lowers to grinding position and begins up-and-down reciprocating motion. Work table turns with housing as it moves on orbital path.
- 4. Wheel oscillates in a horizontal plane about the apex axis to keep the surface of the grinding wheel tangent to the trochoidal curve.
- 5. As the above motions take place, the column carrying the wheel is moved slowly, relative to the frame, to feed the wheel horizontally into the work. This motion controls stock removal.\*
- 6. During grinding sequence, wheel can be dressed once or twice as required for better stock removal or surface finish.
- 7. Upon completion of cycle, wheel feed motion is reset, wheel retracts to its raised position and part is unloaded.

\*NOTE. During grinding cycle, the rate of rotation of the work table can be varied throughout each rotation of the housing to control the peripheral velocity of the bore surface relative to the wheel. This feature can improve part accuracy and provides optimum surface finish control.

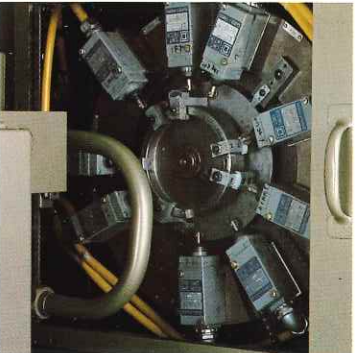
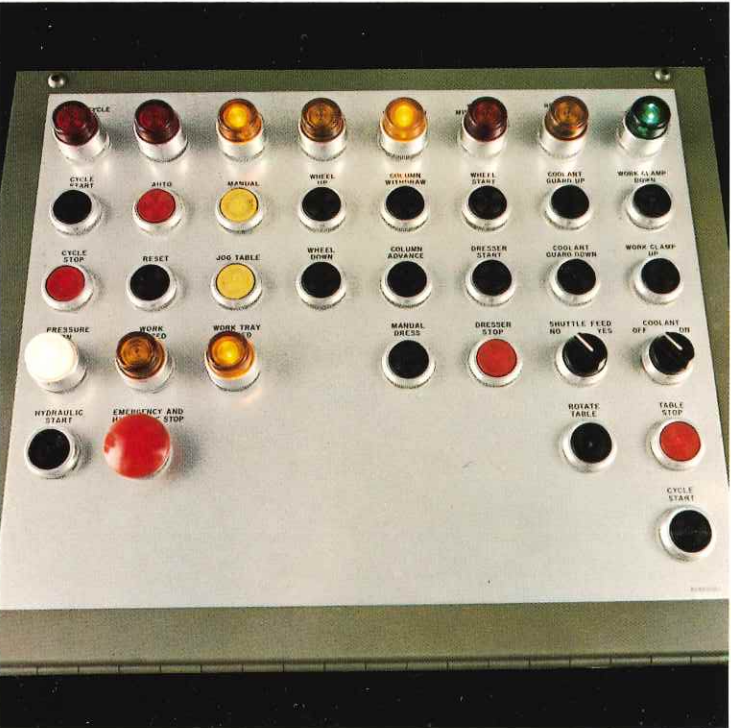


GRINDING WHEEL is driven by a vertical spindle and oscillated by a rotating overhead crank. This action ensures that the grinding wheel axis always intersects a line normal to the surface being ground, so that the grinding wheel surface is always tangent to the work. Wheel diameter changes caused by wear or dressing are accommodated by moving the wheel axis toward the work, along the normal line. Wheel speed is adjustable from 2300 rpm to 6000 rpm to provide optimum results according to the size of the wheel and the material being ground.

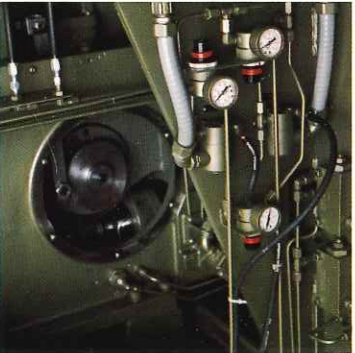
WHEEL DRESSER is a rotary diamond cutter mounted on a precision spindle and driven by a compressed air motor. The dresser reconditions the wheel and provides a precise gaging position for setting the distance "A". The dresser can be set to remove .0005", .001" or .002" per pass, in one to four passes, depending on when the dressing occurs during the sequence of machine operation.



OPERATOR CONTROL PANEL is located adjacent to loading station for operator convenience. Panel includes all major machine functions for setup and for operation.

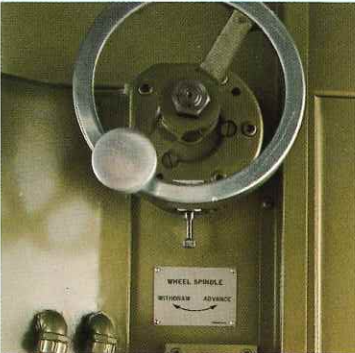


CYCLE DRUM. Controls the feed displacement of the wheel spindle relative to the work spindle. Adjustable switch trips initiate mid-cycle dressing (if used), and changes in feed rate.



ROTATIONAL SPEED CONTROL CAM is easily accessible through cover plate. Rotational speed of workpiece can be varied throughout the 360° cycle to control rate of travel of bore surface past grinding wheel.

HANDWHEEL is used to advance or withdraw grinding wheel relative to the wheel dresser. This adjustment is made when a vitrified wheel is used. When a diamond wheel is used, the handwheel is used to make the actual "A" setting.



MANUAL OR AUTOMATIC LOADING. The configuration of the Gleason No. 808 Trochoid Generating Grinder is a significant factor in its suitability for full automation. Work orientation, loading and unloading, hydraulic power clamping, verification of the part's position in the fixture, infeed, and rotary diamond wheel dressing are all done automatically, if desired.



ELECTRICAL CONTROL BOX. Some switches and controls are mounted on cabinet at drive end of machine.

## No. 808 Cross-Section

### MACHINE DRIVE SYSTEM

The Gleason No. 808 Trochoid Generating Grinder consists of two large and rigid machine members. The lower frame supports a vertical work spindle and the generating system while the upper member holds, a vertical tool spindle and spindle oscillating mechanism.

### UPPER FRAME MEMBER

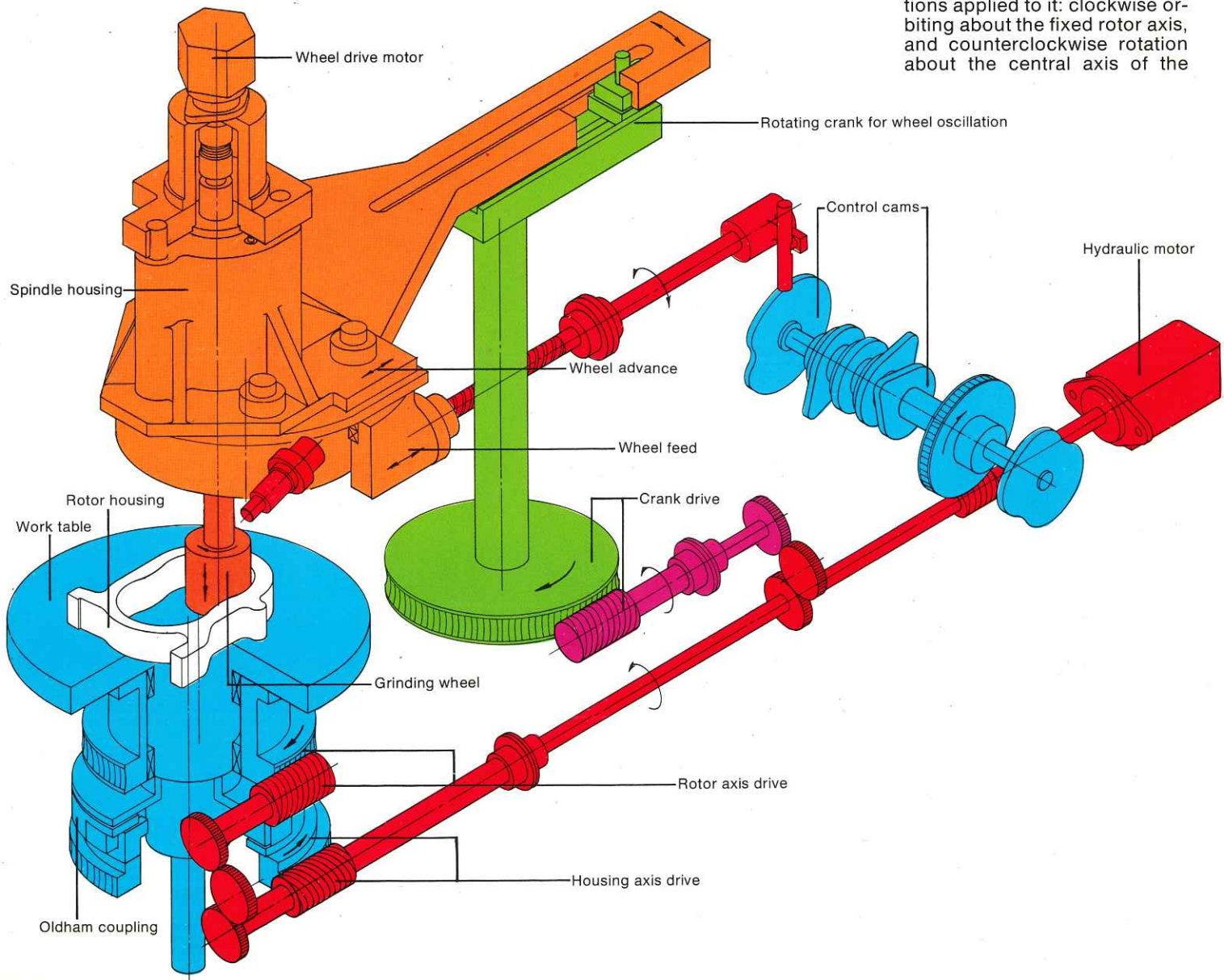
The vertical tool spindle drive system is mounted on machine ways and moves laterally for controlling size, for feed motion and to make modifications in the trochoid chamber shape. Each of these is achieved by

simply changing the distance between the axis of the oscillating grinding wheel support and the fixed axis of the work table.

The quill-type grinding wheel spindle has anti-friction bearings. It is mounted vertically in an oscillating support in the upper member. The arm attached to the support engages a rotating pin driver journaled in the upper frame. The grinding wheel is movable in the direction of the arm to position the tool surface (Distance A) relative to the axis of oscillation through the apex of the imaginary generating rotor.

### LOWER FRAME

In the lower section, the worktable with its workholding fixture carries the rotor housing. The workpiece has two motions applied to it: clockwise orbiting about the fixed rotor axis, and counterclockwise rotation about the central axis of the



trochoid. The generating system incorporates two large worm gear drives which simulate the motions that would be produced by a small external gear engaging with the internal gear of the imaginary generating rotor.

#### OLDHAM COUPLING

The lower worm gear is connected to the rotating work spindle by means of an Oldham coupling. The Oldham coupling is a mechanical coupling containing a cross key member with one keyway on the bottom half and another at right angles to it in the upper half. It transmits rotation from a fixed shaft

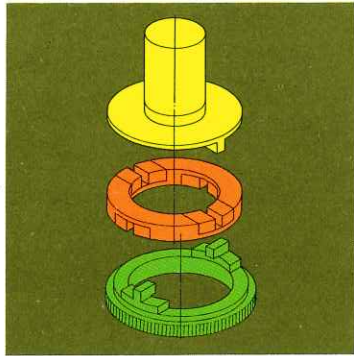
to a moving shaft without altering the motion. A tailpiece extending down through the Oldham coupling provides a route for hydraulic pressure that actuates the workholding equipment on the table and also carries air for the seating inspection mechanism.

#### VARIABLE WORK ROTATIONAL SPEED

The rotational speed of the workpiece can be varied throughout the 360° cycle to control the rate of travel of the bore surface past the grinding wheel for optimum stock removal rates and smooth finish along each portion of the trochoid.

#### MACHINE SETTINGS

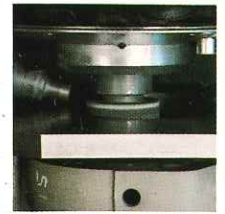
Four simple machine settings enable operator to machine any size rotor housing being produced in large quantities today.



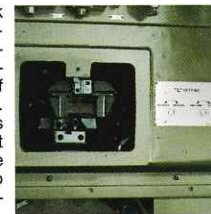
Setting A = apex seal radius. Obtained by positioning the outside diameter of the wheel relative to the apex axis.



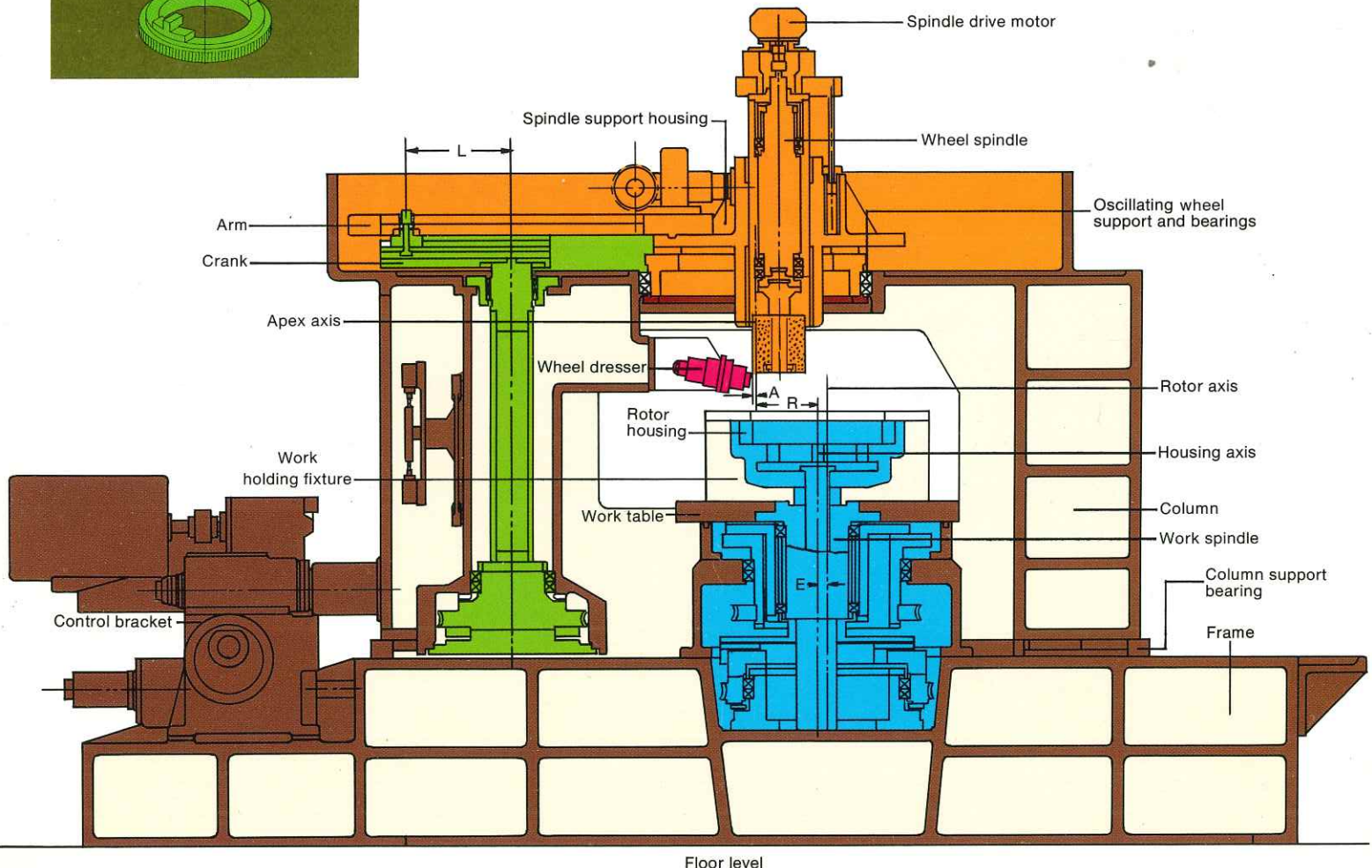
Setting E = engine crank length. Setting is obtained by shifting the work spindle relative to the rotor axis.



Setting L = crank length. This is a machine setting proportional to E/R and determines the amount of wheel oscillation angle.  $L = 3C (E/R)$  where C is a machine constant equal to the distance from the apex axis to the centerline of the rotating crank.



Setting R = radius of engine rotor. This machine setting is obtained by moving the column horizontally on its hydrostatic support surfaces, and is equal to the distance between the apex axis and the rotor axis.



## Specifications—No. 808 Trochoid Generating Grinder

### STANDARD EQUIPMENT

- Automatic feed and size control.
- Arrangement for variable rate of work rotation for one part.
- Adjustable wheel speed drive.
- Automatic guards.
- Arrangement for high volume coolant with connections for central coolant supply system.
- Complete electrical equipment with motors, controls and installation for three-phase, 50 or 60 cycle alternating current.

### EXTRA EQUIPMENT

- Positive type coolant filtration system in place of central supply system
- Refrigeration system for both coolant and hydraulic systems in place of central supply system
- Manual loader with automatic work clamping fixture
- Automatic loader for one size rotor housing
- Arrange loader with load and unload storage magazines for one size rotor housing
- Automatic gaging for control of trochoid size
- Automatic wheel dresser for vitrified wheels (less diamond)
- Rotary diamond for dresser
- Arrange machine for mid-cycle dressing of vitrified wheels
- Setup gage for wheel dresser and diamond wheels
- Arrange machine for automatic wheel speed change at mid-range of vitrified wheel life
- Machine setting bars
- Grinding wheel adapter
- Arrange machine for grinding with diamond wheels including automatic wheel wear compensation
- Arrange machine for trochoid modification (less cam)
- Trochoid modification cam
- Additional work rotation control cam
- Workholding fixture handling equipment
- Sound barrier enclosure

### MACHINE CAPACITY

|                                                       | ENGLISH  | METRIC      |
|-------------------------------------------------------|----------|-------------|
| Rotor apex radius (R)                                 | 0-7.40 " | 0-18.80 cm  |
| Crankshaft eccentricity (E)                           | 0-1.00 " | 0- 2.54 cm  |
| Apex seal offset (A)                                  | 0-0.300" | 0- 0.76 cm  |
| Maximum rotor housing thickness                       | 3.50"    | 8.89 cm     |
| Wheel feed                                            |          |             |
| —Advance and withdraw                                 | 0-0.050" | 0- 0.127 cm |
| Trochoid surface modification                         | 0-0.010" | 0- 0.025 cm |
| Largest major diameter                                | 16.0"    | 40.64 cm    |
| Specifications exceeding the above should be reviewed |          |             |

### WHEEL SPINDLE

|                       |      |          |
|-----------------------|------|----------|
| Minimum O.D. of wheel | 2.5" | 6.35 cm  |
| Maximum O.D. of wheel | 5"   | 12.70 cm |
| Maximum wheel rpm     |      | 6000 rpm |
| Hydrostatic           |      | 6000 rpm |
| Ball Bearing          |      |          |

Smaller wheel diameters and higher spindle speeds are available as special items.

### HOUSING TABLE

|             |        |          |
|-------------|--------|----------|
| Table O.D.  | 27"    | 68.58 cm |
| Maximum rpm | 15 rpm |          |

### MOTORS

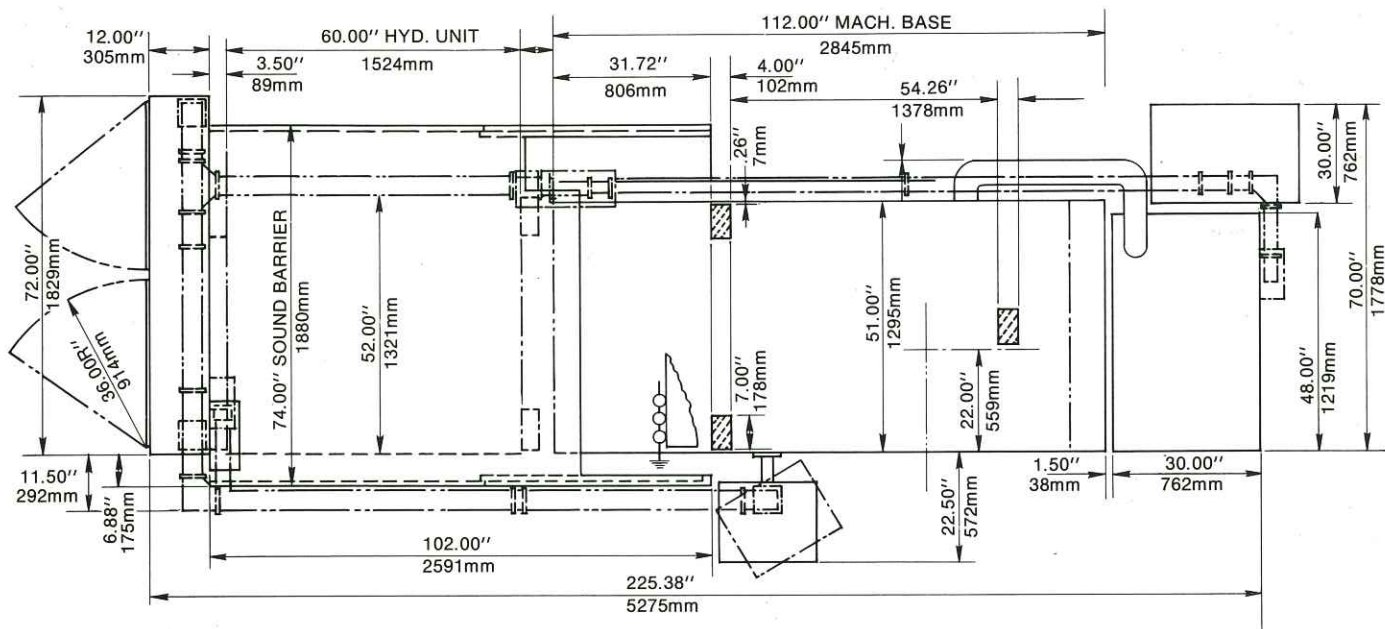
|                          | BALL BEARING SPINDLE | HYDROSTATIC SPINDLE |
|--------------------------|----------------------|---------------------|
| Wheel spindle drive pump | 25 hp                | 30 hp               |
| Machine drive pump       | 7.5 hp               | 7.5 hp              |
| Coolant pump             | 4 hp                 | 4 hp                |
| Hydraulic system         | 3 hp                 | 3 hp                |

### MISCELLANEOUS

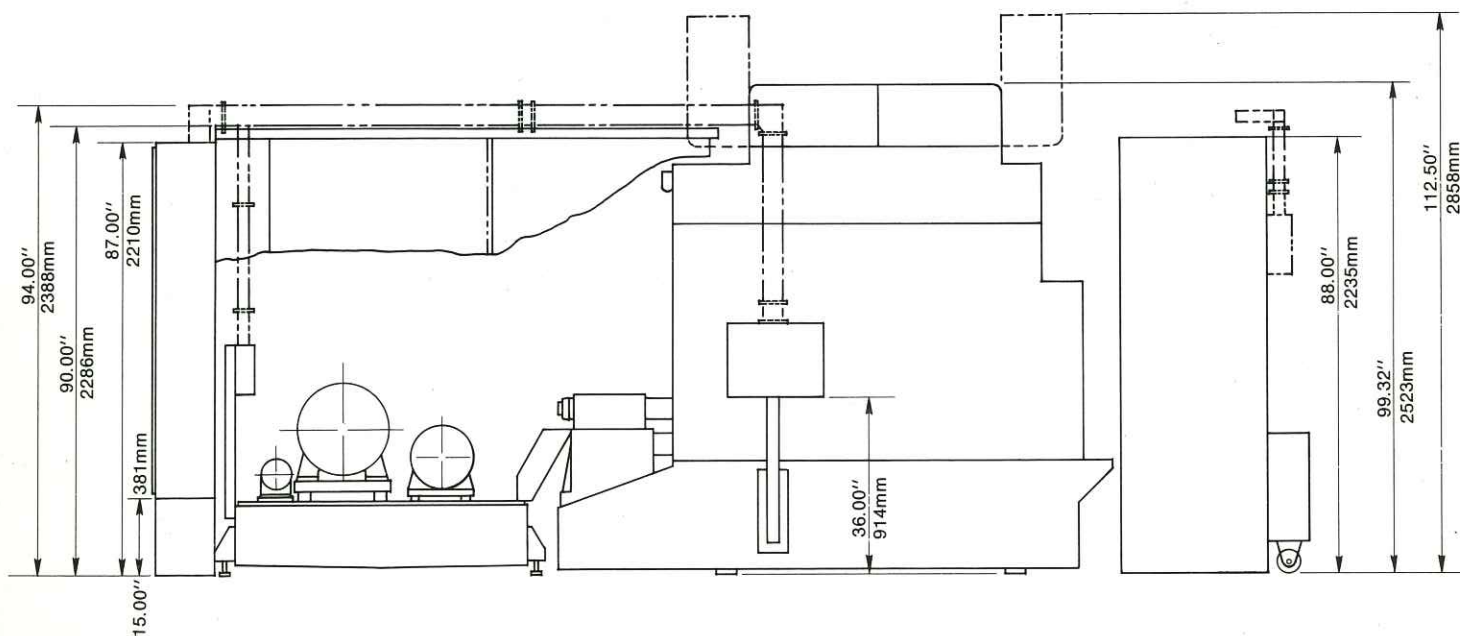
|                                |             |            |
|--------------------------------|-------------|------------|
| Machine weight (est.)          | 30,000 lbs. | 13,600 Kg. |
| Length                         | 112"        | 284.5 cm   |
| Width                          | 51"         | 129.5 cm   |
| Height-to quill cover (closed) | 100"        | 254.0 cm   |
| Height-to quill cover (open)   | 116"        | 294.6 cm   |

# **Dimensions—No. 808 Trochoid Generating Grinder**

Top View



Side View



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